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A New Species of *Apatania* (Trichoptera, Limnephilidae) from Lake Biwa, with Notes on its Morphological Variation within the Lake

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Abstract Descriptions of male, female and larva of *Apatania biwaensis* n. sp. from Lake Biwa are provided. This species is closely related to *A. aberrans* (MARTYNOV), the commonest *Apatania* species in streams in Honshu, but is distinctly distinguishable from it in male and female genitalia and larva. Data on morphological variation in male genitalia suggested that two morphologically distinguishable populations were recognized within the lake. A life history pattern of *A. biwaensis* is briefly shown based on the field and the laboratory observation. The species has an univoltine life cycle and aestivates as prepupa from spring to autumn.

Key words: Trichoptera; Limnephilidae; *Apatania*; new species; Lake Biwa; Japan.

Lake Biwa is the largest and oldest lake in Japan, situated in central Honshu. Many investigetions on macro-zoobenthos including Trichoptera have been conducted since IWATA's pioneer study on caddis larvae (IWATA, 1927 a). TSUDA (1942 a, 1942 b) reported several rare and interesting Trichoptera species from Lake Biwa. The research project on the macro-benthos at the shore of Lake Biwa was conducted from 1984 through 1986. In the course of this study, I recognized a new species of *Apatania*, which was confined to Lake Biwa. In a booklet published as a part of result of the reserch, TANIDA and NISHINO (1992) recorded the species as *Apatania* sp. with photographs of its larva, larval and pupal cases, and adults, but did not conclude its systematic position. The present species is closely related and quite similar to *A. aberrans*, but is clearly distingusihable by the characters in male and female genitalia and the setal characters on the pronotum of larva. The adults and larvae of this species have been collected only from the shore of northern basin of Lake Biwa. In this paper, I will describe a new species, *A. biwaensis* n. sp., a morphological variation in male genitalia between the populations in Lake Biwa is offered, and the life history pattern is briefly mentioned.

Apatania biwaensis n. sp.

(Figs. 1–3)

Apatania sp. TANIDA, 1992: 35.

Adult. Length of forewing, male 8.7–9.2 mm, female 7.7–8.8 mm. Forewing

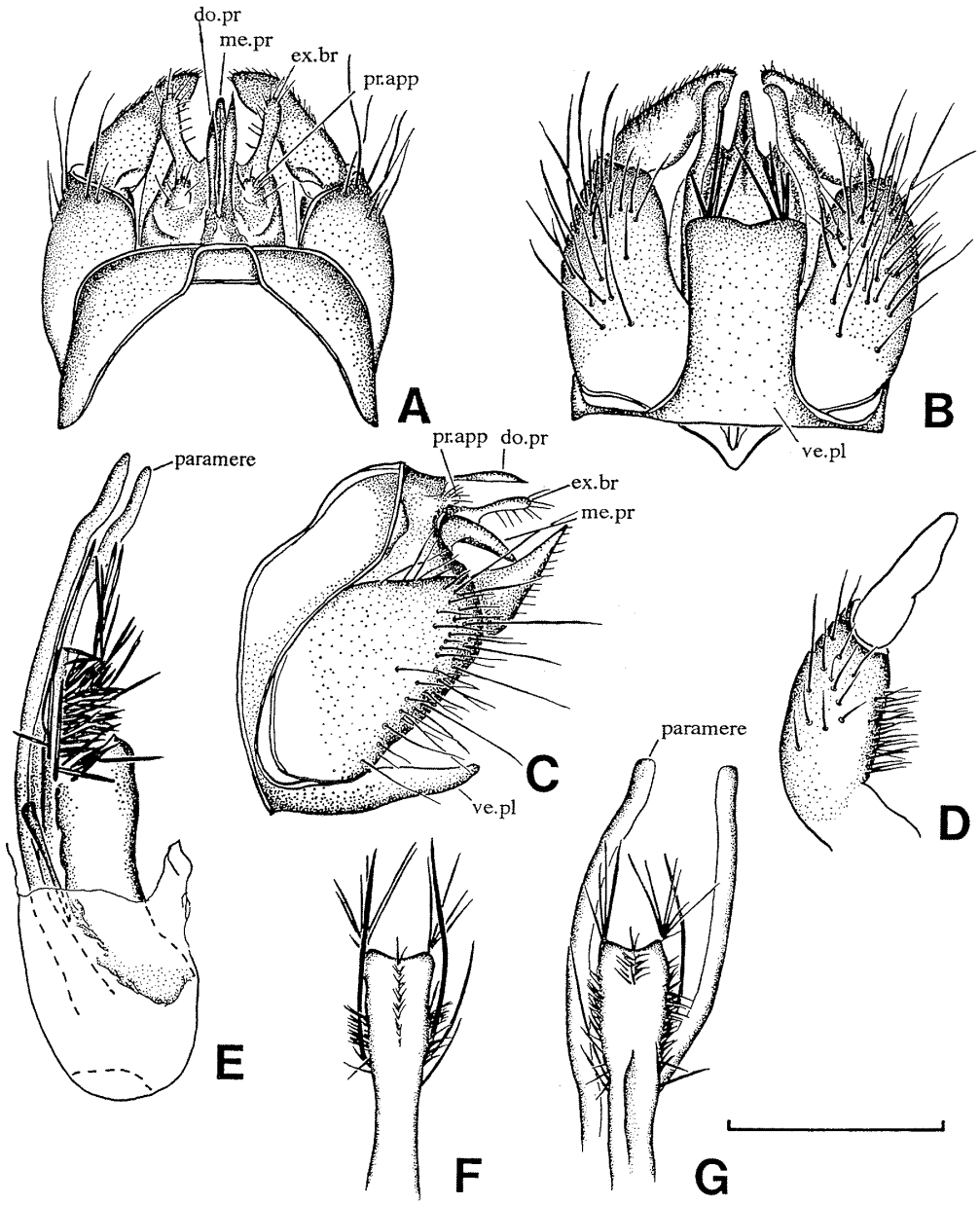

Fig. 1. Male genitalia of *Apatania biwaensis* n. sp.; A, dorsal; B, ventral; C, lateral; D, inferior appendage, caudal; E, phallus, lateral; F, aedeagus, dorsal; G, aedeagus and parameres, ventral. Scale: 0.5 mm. pr. app., preanal appendage; ex. br., external branch; me. pr., median process; dp. pr., dorsal process; ve. pl., ventral plate.

medium brown and hindwing hyaline. Venation typical for the genus.

Male genitalia (Fig. 1): Segment IX with median trapezoidal area on dorsum and a pair of acuminate dorsal processes. The processes usually asymmetrical, variable in length, and sometimes vestigial or lacking; ventral plate large, rectangule, and with a shallow median incision on posterior margin. Basal segment of inferior

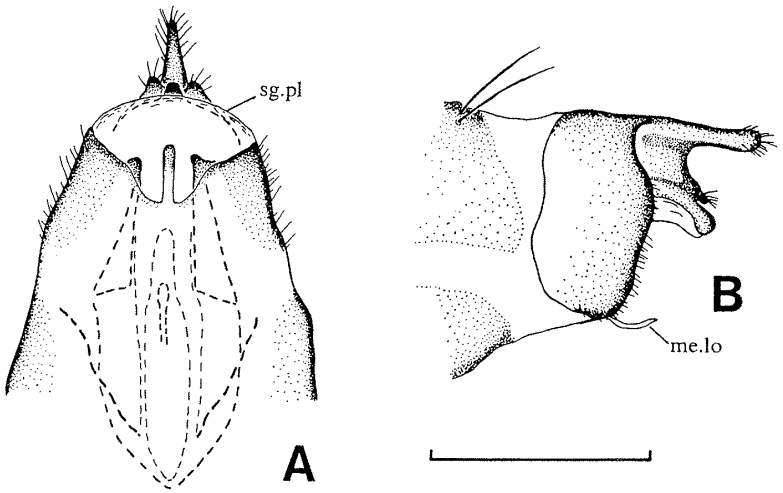

Fig. 2. Female genitalia of *Apatania biwaensis* n. sp.; A, ventral; B, lateral. me. lo., median lobe; sg. pl., supragenital plate. Scale: 0.5 mm.

appendage of segment IX (Fig. 1 D) constricted near base, setose area on mesal surface, and basal third usually pale; terminal segment flatteded dorsoventrally and apex round. External branch of segment X almost cylindrical. Preanal appendage small and semi-circular. Single median process composed by fusion of internal branches of segment X and lobe of segment IX (*sensu* SCHMID, 1953), shorter than external branch, apex pointed and directed posteroventrally. Segment X flattened dorsoventrally, two rounded extensions on caudal margin, and a pair of short lobes at dorsum of base, which are concealed by external branches in dorsal view. In phallus (Fig. 1 E), aedeagus bearing many blade-like bristles on lateral edges and some minute bristles along middorsal line; a pair of long blade-like bristles on lateral edges extending alomost near tips of long bristles arising from apicolateral corners of aedeagus; paramere curved mesally near tips, similar to that of *A. aberrans* but more flattened and widened.

Female genitalia (Fig. 2): In venter of segment IX, median lobe slender with rounded apex, trianguler process visible on each ventral side. Segments IX and X clearly divided; lateral lobe not developed; supragenital plate moderately wide and semi-membranous. Venter of X with three short corn-like processes, medial one longer than others and extended posteroventrally; apex of segment X extended into finger-like process.

Final instar larva (Fig. 3). Overall structure (Fig. 3 A) basically identical with that of *A. aberrans* (AKAGI, 1975).

Length of final instar larva 6.9–7.4 mm, larval case 8.0–8.7 mm. Dorsum of head (Fig. 3 B) reddish to medium brown except for a pair of yellow areas or parts on posterior portion; seta no. 3 2/3 length of seta 2, setae 5 and 6 a little shorter than seta 2, and seta 17 very short; ventral apotome (Fig. 3 C) triangular. Pronotum (Fig. 3 D) reddish to brown except for yellowish anterior part; short, trans-

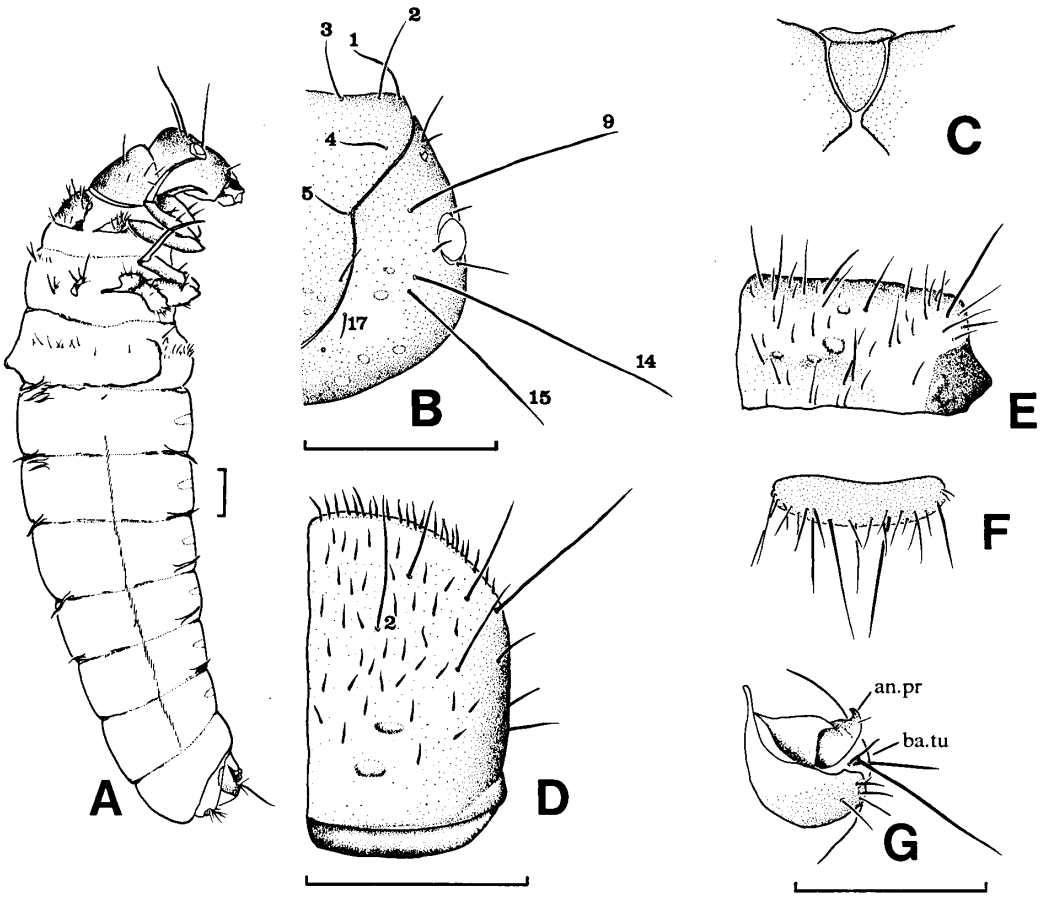

Fig. 3. Larva of *Apatania biwaensis* n. sp.; A, lateral; B, head (right half), dorsal; C, ventarl apotome; D, pronotal tergite (right half); E, mesonotum tergite (right half); F, dorsal sclerite of segment IX; G, anal proleg, latera . Scales: 0.5 mm. an. pr., anal proleg; ba. tu., basal tuft.

parent setae arising from anterior margin of pronotum; each plate with a primary seta no. 2 slightly longer than distance between its socket and dorsal ecdysial line, and lacking some strong setae on posteromesal portion observed in *A. aberrans* (Fig. 5 D). Mesonotum (Fig. 3 E) and metanotum typical for the genus (see WIGGINS, 1977). Abdominal segment I with 11–19 setae between dorsal hump and lateral hump, 10–16 setae on lateral hump, 55–74 setae on venter. Arrangement of abdominal gills is as follows (numbers in parentheses shown variations of gill):

	I	II	III	IV	V	VI	VII
dorsal anterior		2	2 (1)				
dorsal posterior	1 (0)	1	1	1	1		
ventral anterior							
ventral posterior		1	1	1	1	1	1 (0)

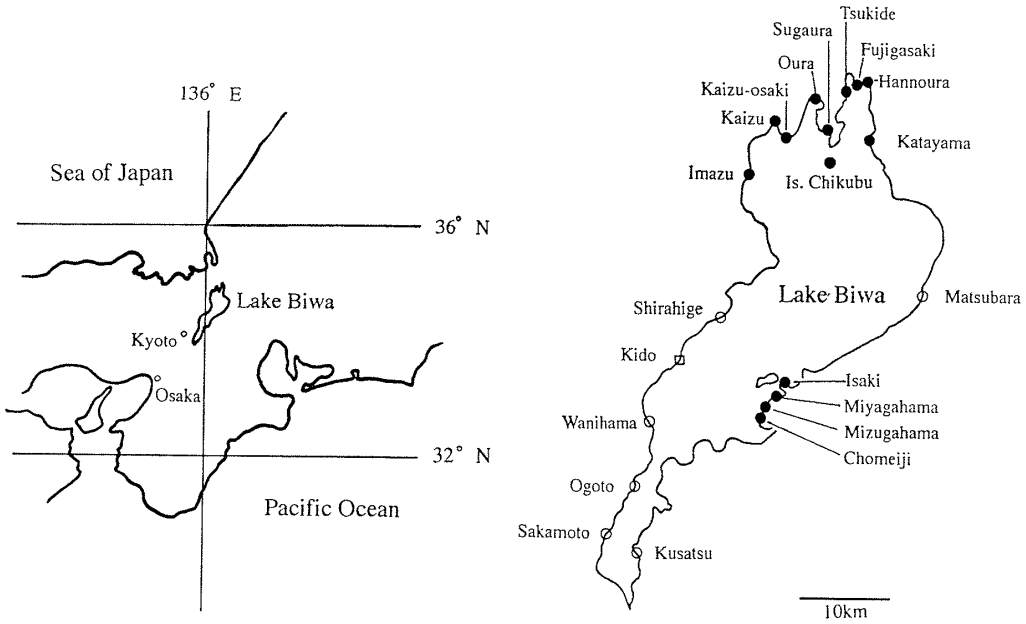

Fig. 4. Distribution of *Apatania biwaensis* n. sp. Solid circles indicate localities where either adults or immature stages were collected; open circles indicate the localities where neither larvae nor adults were not collected; open square indicates locality where only empty cases were collected.

Dorsal plate of segment IX typical for the genus (Fig. 3 F). Claw of anal proleg (Fig. 3 G) without accessory hook or tooth, basal tuft consisting of three stout setae.

Distribution. This species has been only found from Lake Biwa, occuring at rocky shores in the northern basin. The extensive collectings during 1984–1988 revealed that *A. biwaensis* inhabits in 14 localities (Fig. 4). They seem to be restricted to rocky shore with sandy substrate since the larva makes its case of sand grains. They firmly fasten the cases underside of large rocks before summer aestivation. Considering bottom condition, the localities adequate for their habitat are restricted to the northern shores including Chikubu-shima and Take-shima Islands, Matsubara, the area around Okino-shima Island, Imazu, Shirahige, and Wanihama (Fig. 4).

Holotype: ♂, Mizugahama, Lake Biwa, Shiga Pref., 8. XI. 1984 (H. NISHIMOTO).

Paratypes: 4 ♂, Tukide, Lake Biwa, Shiga Pref., 14. XI. 1988; 2 ♂ 9 ♀, ibid., collected as pupae 14. XI. 1988, emerged 19. XI. 1988 (1 ♂ 2 ♀), 22. XI. 1988 (1 ♂ 6 ♀), 27. XI. 1988 (1 ♀); 2 ♂, Oura, Lake Biwa, Shiga Pref., 8. XI. 1984; 2 ♂, ibid., collected as prepupae 2. IX. 1988, emerged 10. XI. 1988 (1 ♂), 27. XI. 1988 (1 ♂); 1 ♀, ibid., collected as pupa 16. XI. 1988, emerged 21. XI. 1988; 1 ♂, Kaizu, Lake Biwa, Shiga Pref., 15. XI. 1988; 1 ♀, ibid., collected as pupa 15. XI. 1988, emerged 19. XI. 1988; 1 ♀, ibid., collected as pupa 16. XI. 1988, emerged 21. XI. 1988; 2 ♂

1 ♀, Imazu, Lake Biwa, Shiga Pref. 16. XI. 1988; 35 ♂ 15 ♀, same data as holotype; 40 ♂ 27 ♀, same locality as holotype, 14–15. XI. 1985; 4 ♂, Chomeiji, Lake Biwa, Shiga Pref. 8. XI. 1984. All collected by H. NISHIMOTO. Holotype and all paratypes are pinned.

Type depository. Holotype and one paratype (♀, same data as holotype) will be deposited in the Biwa Lake Museum (now in construction), Shiga, two paratypes (1 ♂ 1 ♀, same data as holotype) in the Natural History Museum and Institute, Chiba, two paratypes (1 ♂ 1 ♀, same data as holotype) in the Lake Biwa Research Institute, and the other paratypes in the author's collection.

Other adult material. 7 ♂ 11 ♀, Hannoura, Lake Biwa, Shiga Pref., collected as pupae 6. XI. 1986, emerged ? (K. TANIDA); 1 ♂, Fujigasaki, Lake Biwa, Shiga Pref., 6. XI. 1986 (H. NISHIDA); 11 ♂ 20 ♀, Tsukide, Lake Biwa, Shiga Pref., 14. XI. 1988 (H. NISHIMOTO); 3 ♂ 7 ♀, ibid., collected as prepupae ?. X. 1988, emerged ? (H. NISHIMOTO & K. TANIDA); 1 ♂ 1 ♀, Sugaura, Lake Biwa, Shiga Pref., collected as pupae 6. XI. 1986, emerged ? (H. NISHIMOTO); 1 ♂ 12 ♀, western Sugaura, Lake Biwa, Shiga Pref., 19. XI. 1986 (M. NISHINO); 4 ♂ 67 ♀, ibid., 14. XI. 1988 (H. NISHIMOTO); 2 ♂, ibid., collected as prepupae ?. X. 1988, emerged ? (H. NISHIMOTO & K. TANIDA); 15 ♂ 27 ♀, eastern Oura, Lake Biwa, Shiga Pref., 7. XI. 1986, emerged ? (K. TANIDA); 14 ♂ 6 ♀, Oura, Lake Biwa, Shiga Pref., 8. XI. 1984 (H. NISHIMOTO); 2 ♂ 1 ♀, ibid., 13. XI. 1985 (H. NISHIMOTO); 2 ♂ 6 ♀, ibid., collected as prepupae 24. IX. 1986, emerged ? (K. TANIDA); 10 ♂, ibid., collected as pupae 7. XI. 1986 (K. TANIDA); 3 ♂ 2 ♀, ibid., collected as pupae 9. XI. 1986, emerged 9. XI. 1986 (H. NISHIMOTO); 4 ♂ 2 ♀, ibid., 15. XI. 1988 (H. NISHIMOTO); 1 ♂♀, Kaizu-osaki, Lake Biwa, Shiga Pref., 7. XI. 1986 (H. NISHIMOTO); 1 ♀, ibid., collected as pupa 7. XI. 1986, emerged 25. XI. 1986 (H. NISHIMOTO); 3 ♀, ibid., 18. XI. 1986 (M. NISHINO); 1 ♀, Kaizu, Lake Biwa, Shiga Pref., 7. XI. 1986 (H. NISHIMOTO); 13 ♂ 22 ♀, ibid., collected as pupae 7. XI. 1986, emerged ? (K. TANIDA); 51 ♂ 63 ♀, ibid., collected as pupae 7. XI. 1986, emerged 7–17. XI. 1986 (H. NISHIMOTO); 5 ♀, ibid., collected as prepupae ?. X. 1988, emerged ? (H. NISHIMOTO & K. TANIDA); 16 ♂ 1 ♀, ibid., 15. XI. 1988 (H. NISHIMOTO); 13 ♂ 3 ♀, ibid., 11. XI. 1989 (H. NISHIMOTO); 1 ♀, Imazu, Lake Biwa, Shiga Pref., collected as pupa 8. XI. 1986, emerged ? (H. NISHIMOTO); 11 ♂ 1 ♀, ibid., 15. XI. 1988 (H. NISHIMOTO); 77 ♂ 36 ♀, Mizugahama, Lake Biwa, Shiga Pref. 8. XI. 1984 (H. NISHIMOTO); 13 ♂ 12 ♀, ibid., 14. XI. 1985 (H. NISHIDA & H. NISHIMOTO); 6 ♂ 10 ♀, ibid., 14. XI. 1985 (H. NISHIDA); 10 ♂ 11 ♀, ibid., 15. XI. 1985 (H. NISHIDA); 25 ♂ 19 ♀, ibid., 15. XI. 1985 (H. NISHIMOTO); 39 ♂ 13 ♀, ibid., 4. XI. 1986 (H. NISHIDA); 5 ♀, ibid., 10. XI. 1986 (M. NISHINO); 1 ♂ 1 ♀, ibid., collected as pupae 14. XI. 1986, emerged ? (M. NISHINO); 1 ♂ 7 ♀, ibid., collected as prepupae 25. IX. 1986, emerged ? (K. TANIDA); 15 ♂ 12 ♀, ibid., 14. XI. 1988 (H. NISHIMOTO); 16 ♂ 15 ♀, ibid., 16. XI. 1988 (H. NISHIMOTO); 7 ♂ 7 ♀, ibid., 11. XI. 1989 (H. NISHIMOTO); 9 ♂ 3 ♀, Chomeiji, Lake Biwa, 8. XI. 1984 (H. NISHIMOTO); 2 ♀, ibid., collected as pupae 15. XI. 1986, emerged ? (M. NISHINO). Other adult material are preserved in 70% of ethanol.

Larval material. 1 ex., Fujigasaki, Lake Biwa, Shiga Pref., 9. IV. 1988 (H. NISHIMOTO); 4 exs., Oura, Lake Biwa, Shiga Preff., 10. IV. 1988 (H. NISHIMOTO); 3 exs., Kaizu, Lake Biwa, Shiga Pref., 10. IV. 1988 (H. NISHIMOTO); 1 ex., Imazu, Lake Biwa, Shiga Pref., 8. IV. 1988 (H. NISHIMOTO).

Prepupal material. 2 exs., Katayama, Shiga Pref, 10. IX. 1986 (N. KOBAYASHI); 34 exs., Fujigasaki, Lake Biwa, Shiga Pref., 10. IX. 1986 (N. KOBAYASHI & H. NISHIDA); 4 exs., Tsukide, Lake Biwa, Shiga Pref., 22. VIII. 1986 (M. NISHINO); 1 ex., ibid., 10. IX. 1986 (H. NISHIDA); 4 exs., ibid., 5. VIII. 1987 (M. NISHINO); 16 exs., Sugaura, Lake Biwa, Shiga Pref., 10. IX. 1986 (H. NISHIDA & M. NISHINO); 1 ex., western Sugaura, Lake Biwa, Shiga Pref., 10. IX. 1986 (N. KOBAYASHI); 1 ex., eastern Oura, Lake Biwa, Shiga Pref., 5. XI. 1986 (M. NISHINO); 4 exs., Oura, Lake Biwa, Shiga Pref., 19. X. 1984 (K. TANIDA); 14 exs., ibid., 23. VIII. 1986 (M. NISHINO); 2 exs., ibid., 7. XI. 1986 (N. KOBAYASHI); many specimen, ibid., 2. IX. 1988 (H. NISHIMOTO, T. KIMURA & T. KOIDE); 1 ex., Kaizu-osaki, Lake Biwa, Shiga Pref., 4. VIII. 1986 (N. KOBAYASHI); 25 exs., Kaizu, Lake Biwa, Shiga Pref., 11. IX. 1986 (H. NISHIDA, N. KOBAYASHI & M. NISHINO); 16 exs., ibid., 7. XI. 1986 (H. NISHIMOTO); 2 exs., ibid., 10. IV. 1988 (H. NISHIMOTO); 2 exs., Imazu, Lake Biwa, Shiga Pref., 11. IX. 1986 (H. NISHIDA); 8 exs., ibid., 8. XI. 1986 (H. NISHIMOTO); 3 exs., ibid., 8. IV. 1988 (H. NISHIMOTO); 1 ex., Is. Chikubu, 22. X. 1985 (H. NISHIMOTO); 1 ex., ibid., 3. VIII. 1988 (M. NISHINO); 14 exs, Isaki, Lake Biwa, Shiga Pref., 9. IX. 1986 (H. NISHIDA); 5 exs., Miyagahama, Lake Biwa, Shiga Pref., 9. IX. 1986 (M. NISHINO & H. NISHIDA); 1 ex., ibid., 5. XI. 1986 (M. NISHINO); 1 ex., Mizugahama, Lake Biwa, Shiga Pref., 22. X. 1985 (H. NISHIMOTO); 59 exs., ibid., 9. IX. 1986 (H. NISHIDA, N. KOBAYASHI & M. NISHINO); 4 exs., ibid., 5. IV. 1987 (H. NISHIMOTO); 14 exs., ibid., 9. IV. 1988 (H. NISHIMOTO); many specimens, ibid., 2. IX. 1988 (H. NISHIMOTO, T. KIMURA & T. KOIDE); 1 ex., Chomeiji, Lake Biwa, Shiga Pref., 21. V. 1986 (M. NISHINO); 2 exs., ibid., 1. VII. 1986 (N. KOBAYASHI).

Pupal material. 6 exs., Katayama, Lake Biwa, Shiga Pref., 5. XI. 1986 (N. KOBAYASHI & M. NISHINO); 52 exs., Hannoura, Lake Biwa, Shiga Pref., 6. XI. 1986 H. NISHIMOTO, N. KOBAYASHI & M. NISHINO); 12 exs., Tsukide, Lake Biwa, Shiga Pref., 6. XI. 1986 (H. NISHIMOTO & N. KOBAYASHI); 18 exs., Sugaura, Lake Biwa, Shiga Pref., 6. XI. 1986 (H. NISHIMOTO, M. NISHINO & N. KOBAYASHI); 16 exs., eastern Oura, Lake Biwa, Shiga Pref., 7. XI. 1986 (H. NISHIMOTO & M. NISHINO); 28 exs., Oura, Lake Biwa, Shiga Pref., 7. XI. 1986 (H. NISHIMOTO, M. NISHINO & N. KOBAYASHI); 4 exs., Kaizu-osaki, Lake Biwa, Shiga Pref., 7. XI. 1986 (H. NISHIMOTO); 75 exs., Kaizu, Lake Biwa, Shiga Pref., 7. XI. 1986 (H. NISHIMOTO, M. NISHINO & N. KOBAYASHI); 11 exs., Imazu, Lake Biwa, Shiga Pref., 8. XI. 1986 (H. NISHIMOTO); 9 exs., Miyagahama, Lake Biwa, Shiga Pref., 5. XI. 1986 (M. NISHINO & N. KOBAYASHI). Larval, prepupal, and pupal material are preserved in 70% of ethanol.

Diagnoses. This species is very similar to *A. aberrans.* A pair of dorsal processes on the abdominal segment IX in the adult male is characteristic of *A. biwaensis* since *A. aberrans* has no dorsal processes at all. However, those processes are

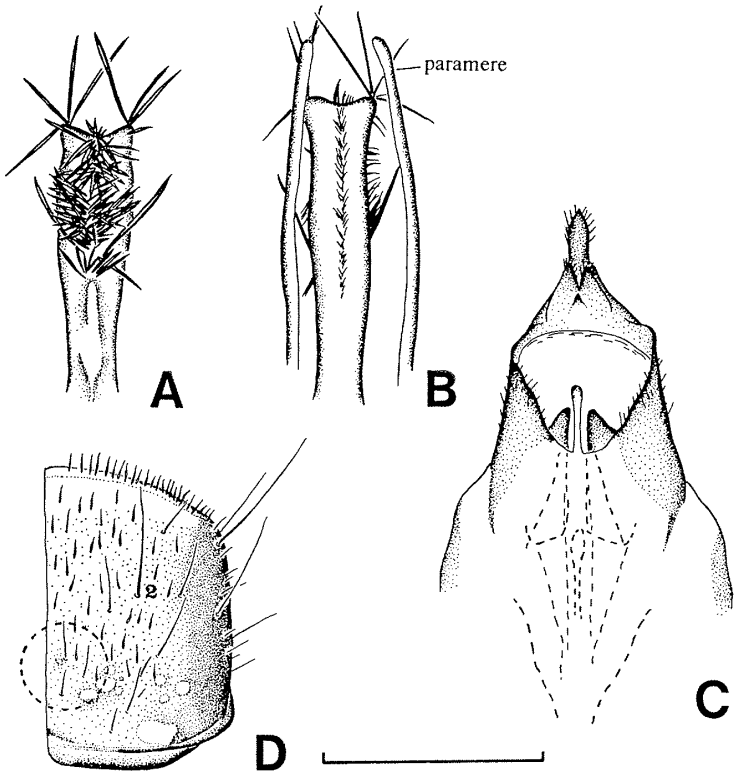

Fig. 5. *Apatania aberrans* (MARTYNOV); A, aedeagus, ventral; B, aedeagus and parameres, dorsal; C, female genitalia, ventral; D, pronotal tergite (right half). Scale: 0.5 mm. Figures are based on specimens from Nikkou, Tochigi Pref., 16. X. 1984 for adult and Takihata, Kawachinagano, Osaka Pref., 25. IX. 1985 for larva.

variable in length and sometimes completely absent. Thus the consistent diagnostic characters of the male of *A. biwaensis* to distinguish from that of *A. aberrans* are as follows: in phallus, aedeagus bearing many blade-like bristles on lateral edges and some minute bristles on apicoventral portion; pair of very long bristles on lateral edges extending almost to tips of long bristles arising from apicolateral angles of aedeagus; paramere similar to that of *A. aberrans* (Fig. 5 B), but more flattened and widened. In *A. aberrans*, the aedeagus bears many blade-like bristles on the ventral surface and many miute bristles along the middorsal line (Figs. 5 A–5 B); a pair of lateral long bristles do not extend beyond the tip of aedeagus (Fig. 5 A).

In the female genitalia, the venter of segment X bears three short corn-like processes, the medial one being larger and more produced than the others, whereas in *A. aberrans* the venter of segment X bears three pointed processes, the medial one being much smaller than the posterior pair (Fig. 5 C). In the larva, strong secondary setae are absent from the posteromesal portion of the pronotal sclerite, whereas in *A. aberrans* there are a few strong ones on that portion (area surrounded with dotted line, Fig. 5 D).

Table 1. Variation in the length of dorsal process on tergite IX in male of *Apatania biwaensis* n. sp., collected during 1984–1988.

Locality	Year	Degrees of length				
		I	II	III	IV	V
Southern population						
Mizugahama	1984	8	23	14	13	9
	1985	4	19	9	10	12
	1986	3	10	10	8	12
	1988	6	8	5	6	6
Chomeiji	1984	1	6	1	1	
	Total	22	66	39	38	39
Northern population						
Fujigasaki	1986	1				
Tsukide	1988	14				
Sugaura	1986	2				
	1988	6				
Oura	1984	12	2			
	1985	2				
	1986	28	1	1		
	1988	1		2	1	
Kaizuosaki	1986	2				
Kaizu	1986	61	2	1		
	1988	14	1	1		
Imazu	1988	9	2			
	Total	152	8	5	1	

Only specimens preserved in 70% of ethanol were measured. Numeral indicated the number of individuals in each degree; I, dorsal process (do. pr) completely lacking; II, do. pr less than 1/3 of length of external branch (ex. br); III, do. pr 1/3–1/2 of length ex. br; IV, do. pr 1/2–2/3 of length of ex. br; V, do. pr more than 2/3 of length of ex. br.

Variation. The males of *A. biwaensis* usually have a pair of the dorsal processes in the tergum IX which is the easiest visible chatacter to distinguish them from those of *A. aberrans*, However, the process varies in length as mentioned above. Table 1 shows the result of the division of specimens into five classes on the basis of the length of the dorsal process in each year and locality. The relative abundance of these types was significantly different between southern and northern populations (G-test, $P<0.005$). In the northern population, most males lacked the dorsal process (degree I) and no specimens had the process that was longer than the external branch. There was no significant difference between the localities of the northern population (G-test, $P>0.995$). In the southern population, males had longer process and the frequencies of each degree were not so different each other. No significant year to year differences were observed in Mizugahama population (G-test, $P>0.5$).

Life cycle. Some active last-instar larvae were captured at Imazu and Kaizu

together with many prepupae on 8 and 10 April, 1985, respectively. Prepupae close their openings of cases and aggregate on the under ace of large rocks. In the prepupal case, prepupa is quiscence and has somewhat swollen body. I was able to find the prepupae over seven months, from early April (the earliest date, 5 April at Mizugahama) through late October (the latest date, 22 October at Oura). Pupae were recognized in early November. As far as I know, adults appeared from 4 November (1986, Mizugahama) to 16 November (1988, Mizugahama). In the emergence records of adults reared from pupae at the tempaerature of ca. 10°C in the laboratory, they emerged 7 to 25 November. Laboratory observations were made on the oviposition and hatching with several adults collected from Mizugahama, 14 November, 1988, They were put into a glass container (26 cm $\times$40 cm $\times$27 cm) with water. One pair copulated two days after the collection. Eight females deposited egg masses during seven days. The egg mass was orange in colour and hemisphere in shape and covered with gelatinous matrix. It was ca. 2.4 mm in diameter be ore absorbing water and contained 150 to 200 eggs. Larvae hatched about 10 days after oviposition (water temperature ca. 12°C). The larvae came out from the eggmass and made their cases immediately after hatching, and they became inactive.

These facts indicate that the larva rapidly grows under low water temperature period between November and March and the aestivation at prepupal stage starts from spring and ends autumn. The pupation probably occurs a few weeks before the emergence of adult. This species apparently exhibits an univoltine life cycle with a late autumn emergence period.

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Occurence and Host Preference of the Barnyard Grass Stem Borer, *Enosima leucotaeniella* (RAGONOT) (Lepidoptera, Pyralidae), in Peninsular Malaysia

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Key words: *Echinochloa*; barnyard grass; *Enosima leucotaenilla*; stem borer; Peninsular Malaysia.

The rapid change from transplanting to direct seeding (broadcasting) in rice cultivation practice in Peninsular Malaysia has induced tremendous increase of grassy weeds,

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